Predicting Pilot Retention

GRADUATE RESEARCH PROJECT

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AFIT-IMO-ENS-12-13

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT-IMO-ENS-12-13

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GRADUATE RESEARCH PROJECT

Presented to the Faculty

Department of Engineering and Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics

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June 2012

AFIT-IMO-ENS-12-13

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Abstract

The research problem was to determine if it is possible to predict future pilot retention based on factors internal and external to the Air Force in order to identify if there is a potential future shortage. Specifically, this research sought to answer three research questions about how future pilot requirements and inventories are forecast, determining if there are factors that may predict retention habits, and finally if a model could be formulated using those factors that would help predict pilot retention.

This study was focused towards the Air Staff and OSD to illustrate potential manning shortfalls as well as hopefully to identify factors that may alleviate those risks. Due to the high amount of training time and dollars required to replace them, this study focused solely on pilots and only looked ten years out for requirements since the current ADSC for initial pilot training is ten years. Research indicated that the Air Force does not use external factors that have proven to be significant in predicting pilot retention. This research created a formula for predicting pilot retention that can be used by senior policy members to better forecast retention behavior in order to shape force management more effectively.

To my wife and daughter

Acknowledgments

I would like to take this opportunity to thank a few individuals who provided me guidance and motivation during the creation of this project. First of all, I need to thank my advisors Dr. Stephen Chambal and Lt Col Shay Capehart, for giving me just enough rope to do the project my way without allowing me to hang myself in the process. Additionally, I would like to thank all of my professors during my time in ASAM. You've opened my eyes to a whole new world. My thanks to Maj Eric Weber, ASAM graduate of 2010, for giving me the access to all the data I needed as well as being so patient with my questions. I am indebted to all my classmates for their help throughout the year, especially to Maj Mark Oberson, who originally came up with the idea for this topic and allowed me to take the reins. To my daughter, thanks for reminding me that it's okay to take a break and just play every now and then. Finally, to my wonderful wife, I can't say thank you enough for putting up with me throughout the last year as well as cooking countless meals and treats for the class. You'll never know how much your love and support truly mean to me, but I vow to never quit trying to relay that message. The road goes on forever…Gig 'Em!

Dale W. Stanley III

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PREDICTING PILOT RETENTION

I. Introduction

General Issue

According to the article "Pilot Shortage" in the Air Force Times, the United States Air Force is facing a major shortage of fighter pilots that is taking a toll not only on the fighter community but the rest of the pilot inventory as well. Currently, the Air Force has the capability to absorb up to 230 fighter pilots per year, but needs to train just over 300 a year in order to meet requirements. If left uncorrected, the Air Force would not have enough fighter pilots to man its fighter squadrons, let alone any of its air liaison officer (ALO), test and staff positions by 2017 according to current projections (Laster and others, 2012:20-21).

The Air Staff produces a Red Line/Blue Line (RL/BL) chart where the red line represents the pilot requirements either for a certain demographic (fighter, mobility, etc.) or as a whole. Meanwhile, the blue line represents the inventory of pilots on hand for all the associated requirements respectively. In Figure 1, the projections for FY11 were projecting to have fewer pilots than requirements for FY13 and to then start exceeding requirements in future years (HAF/A1PP, 2011:18). Where the Combat Air Forces (CAF) are not able to train enough pilots to meet year to year requirements, the Mobility Air Forces (MAF) are currently able to train more than necessary to sustain their yearly projected losses and fill rated fighter positions as well as some ALO positions. From this chart, you can see that overall pilot manning is proceeded to exceed requirements from FY15 to FY17.

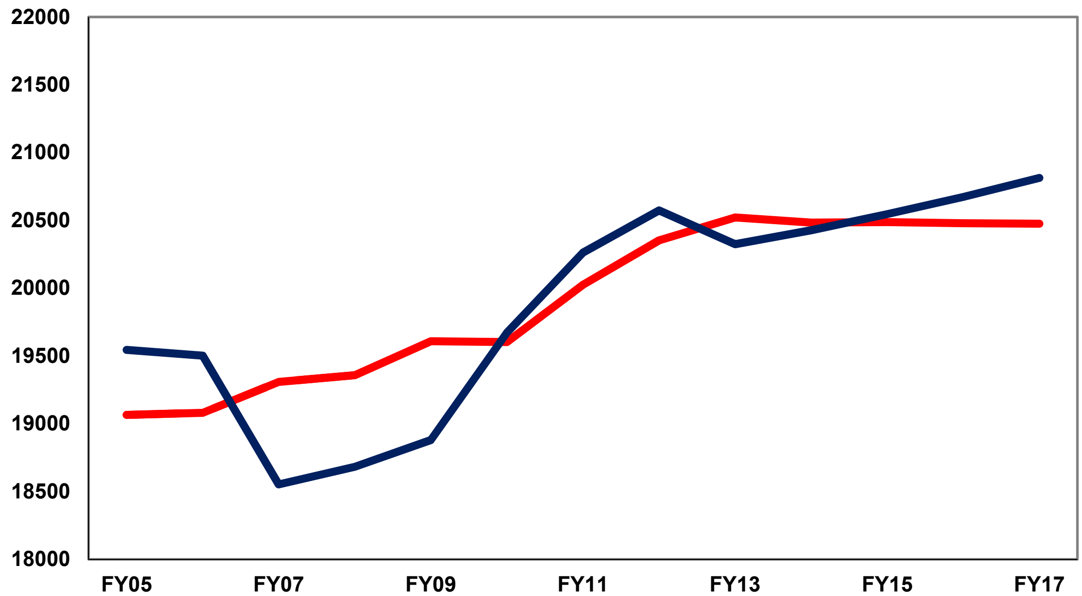


Figure 1: Red Line/Blue Line FY11

Problem Statement

There are troubling signs that pilot retention might become an issue in the near future. In 2011, the USAF offered a Voluntary Separation Pay (VSP) program to targeted year groups and competitive categories to get to congressionally mandated end-strength. Of the 915 applicants for this program, over 400 of those applicants were pilots. However, only 25 pilots were approved to receive VSP, a percentage of over 8% of the approved applicants. In comparison, the approval rate for all other career fields combined was approximately was nearly 47% (HAF/A1PP, 2011:11). Additionally, nearly half of the pilots who applied for VSP came from the MAF, the same career field filling the CAF non-flying requirements

The reason given for the discrepancy was that approving those rated officers would have a “detrimental effect on current and future Air Force operations…” (“VSP/RIF Q&A”, AFNews.com, 2011) Meanwhile, at the Airbus Global Market Forecast press conference in London, Airbus executive John Leahy spoke of how worldwide air traffic had doubled every 15 years since the 1970’s and that the average annual growth had been 4.8% over the last 20 years. Airbus predicted that these trends would continue as emerging economies, especially in Asia, were creating a fast growing middle class that would fuel airline growth (Airbus, 2011:18, 23). By 2029, airlines are predicted to hire nearly one hundred thousand pilots in North America and nearly 250,000 worldwide (Jones, 2011). Based on 265 approved VSP applications, the approval rate was approximately 30% overall (HAF/A1PP, 2011:11). If 30% of the pilots who applied had been approved, that would account for 120 pilots leaving the service. If losing approximately 100 additional pilots would impact operations long-term, is the United States Air Force facing a future retention problem that will make it unable to meet its war and peacetime missions?

Unfortunately, it takes much longer to work out of a pilot shortage than it does to fix a pilot surplus. For example, due to delays in training, it can take as much as five to six years to get a newly commissioned officer through various flying training programs and assigned to a fighter squadron (Laster and others, 2012:20). On the other hand, various force management programs such as Reduction in Force (RIF) and Selective Early Retirement Boards (SERB) can put excess airmen out in less than a year when necessary in order to meet end strength requirements.

The research problem is to determine if it is possible to predict future active duty pilot retention based on factors internal and external to the Air Force to ascertain if there is a potential future shortage. Concerns over pilot retention are not just a recent issue. In 1982, Cromer and Julicher wrote on the pilot retention issues the Air Force faced in the late 1970's (1982). A point of national security interest, the issue of pilot retention was brought directly before Congress:

> In testimony before the House Armed Services Committee in July 2001, the Chief of Staff of the Air Force cited retention as the most pressing problem facing the Air Force. Retaining pilots … was proving particularly difficult. (Mattock and Arkes, 2007:1)

Since pilot retention has been a recurring issue for the Air Force, the ability to predict future pilot shortages could help to alleviate the negative effect that such a situation would have on the Air Force's ability to meet a Combatant Commander's requirements.

Research Objectives/Questions/Hypotheses

To focus this research, three specific sub-questions were developed and must be researched. To begin with, it is necessary to determine how the Air Force identifies future pilot inventories and requirements. In order to be able to ultimately gauge if pilot production and retention rates are aligned in order to meet requirements in the future, it will be necessary to ascertain how the requirements are defined as well as determining how best to predict retention.

Another question to be answered when doing the research is what factors can serve as predictors when determining whether a pilot will remain on active duty past their initial service commitment. While other studies have implied that airline hiring rates are a significant factor, are there other factors such as national unemployment or education level that can lead to building a better model for predicting rated retention? This research will need to pull data from a number of sources, internal and external to the Air Force, in order to build the most accurate model possible.

The overarching hypothesis is that from these sources, a model can be formulated that can forecast future rated manning levels by using hypothetical numbers to predict what percentage of pilots would remain on active duty given certain factors. Every year, the Air Force Personnel Center (AFPC) releases a rated retention analysis report detailing retention statistics for pilots. One metric used in this report is that of Cumulative Continuation Rate (CCR). CCR is the percentage of rated officers who remain in service for a given period of time. A 60% CCR for Air Force pilots in the 6-14 year group means that for every one hundred pilots entering the 6th year of commissioned service, sixty pilots would complete the 14th year, if current rates persisted (Department of the Air Force, 2009: 48). However, this metric is strictly historical so it offers no predictive ability. The goal is to create a metric that is a more effective tool for senior policy makers.

Research Focus

This study would be focused towards the Air Staff and Office of the Secretary of Defense (OSD) to illustrate potential manning shortfalls as well as to hopefully identify factors that may alleviate those risks. In order to limit the scope of the problem, the research will not focus on the demographics of any given population of pilots such as commissioning source or number of dependents. Due to the high amount of training time and dollars required to replace them, this study will focus solely on pilots and will only look at pilot retention through fourteen years of commissioned service.

Assumptions/Limitations

A key assumption during this research is that there is not a significant change to the financial incentives such as Aviator Continuation Pay (ACP) offered to active duty pilots. Along that same train of thought, this study will make the assumption that there is no significant change to the retirement benefits offered to pilots. While significant cuts are possible based on the current economic pressures facing the military, it is beyond the scope of this research to speculate on what the effects of any major financial changes would be on pilot retention. One significant change to the ACP during the research period examined was the cancellation of the bonus to twenty years of service starting in 2005 (AFPC/DPAPA, 2011).

This research did not include collecting data from pilots who have chosen to separate after their initial service commitment. As mentioned previously, prior research focused on specific demographics of pilots who chose to leave. It is beyond the scope of this project to accurately quantify the effects of a certain number of deployments or dependents on an individual pilot's decision to leave or stay on active duty. This research will focus more on the external environmental factors helping to shape that decision which are not unique to an individual but common to all pilots such as promotion opportunities or national unemployment rates.

Due to some data collection limitations, this project looked specifically at the time period from 1998 to 2011. During that time period, 2007 was the only year when force shaping measures were applied to non-retirement eligible pilots. The effects of the 2011 RIF and VSP will not be shown until 2012 due to the fact that these separations would take place in the 2012 fiscal year. As such, force shaping would only have one data point so it would be difficult to draw conclusive evidence for a predictive effect on retention. This would be especially true as force shaping measures can change from year to year.

One final limitation of this paper would be an inability to measure the difference in pay for pilots who are on active duty and those who are flying for the airlines. While average pay can be determined, the benefits can be hard to value, especially as many national carriers have gone through bankruptcy, affecting the benefits of their pilot unions over time. For the sake of this research, the average pay of airline pilots over the aforementioned time period will be used to represent the difference in pay. The theory behind that would be that a military pilot would be able to look out at what the average commercial pilot is making and compare it to what they are currently making on active duty.

II. Literature Review

Chapter Overview

In order to begin to create a predictive model for pilot retention, it is necessary to first know how the pilot inventory is currently calculated and projected into the future. Furthermore, a comprehensive literature review on active duty pilot retention in the Air Force can help to identify factors that may be worth examining for helping to predict retention behavior. By understanding the current means of predicting pilot inventories and retention rates as well as determining a list of factors that may be significant to any given pilot's decision to remain or separate from active duty, data can be collected in order to build a regression model that can predict pilot retention with some degree of confidence.

Blue Line Computations

The RL/BL is an Air Staff product used to predict shortages or surpluses in rated inventories in comparison to rated requirements. To begin with, it is important to understand that the Red Line for requirements is not a static number but can change drastically based on any number of factors, including but not limited to the addition of an airframe such as the MC-12 or C-27, a change in congressionally mandated end strength or even the re-categorization of pilots to the remotely piloted aircraft (RPA) career field.

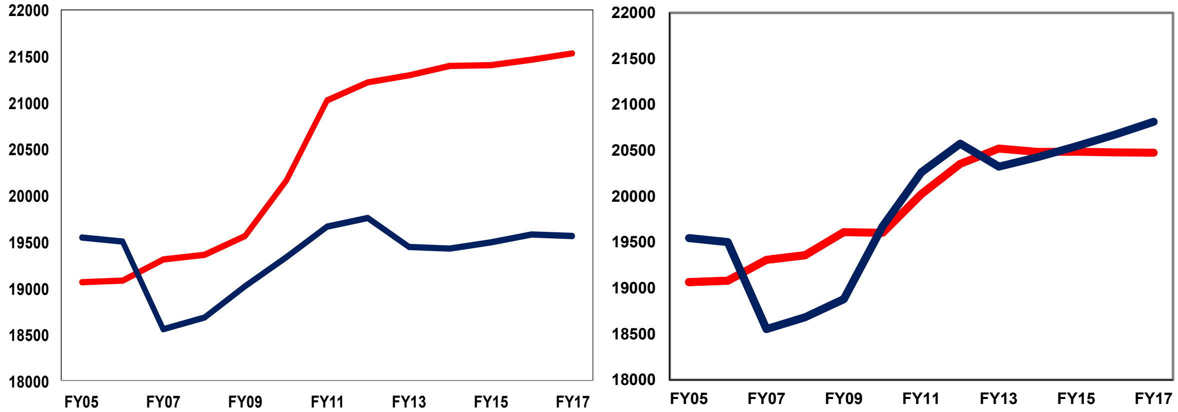


Figure 2: Comparison of 2009 and 2010 RL/BL Charts

Figure 2 shows the April 2009 and April 2010 RL/BL charts (HAF/A1PP, 2011:18). They are drastically different due to the rated recall program of 2009 as well as the creation of the 18X career field that help alleviate the burden of filling a growing RPA requirement, among other initiatives. In one year, the RL/BL changed from a 2,500 pilot shortage to having a small surplus of pilots by 2017. This serves as an example of how difficult it can be to determine requirements from year to year.

Rapid fluctuations like these are referred to in supply chains as a bullwhip effect. A bullwhip effect is common in supply chains that lack the ability to respond quickly to changes in demand. These types of supply chains then incur the costs of oversupply and the opportunity costs of shortages (Lambert, 2008:133). One of the major causes of bullwhip effects is demand forecasting with a product that requires long lead times to produce. Since pilots can take several years to produce, the RL/BL is subject to bullwhip types of effects. Unfortunately, it is difficult to predict with any certainty what requirements will be in the long term due to changes in the defense budget and national security strategy, for example. Therefore, it is imperative to better forecast the Blue Line in order to minimize the negative effects of a bullwhip effect.

Creation of the Blue Line is owned and managed by the A1's Rated Force Policy Branch (HQAF/A1PPR) for the purpose of obtaining official pilot inventory projections. A pilot is included in the inventory if they are below the grade of Colonel, have obtained their aeronautical rating, and are not permanently grounded. Blue Line forecasts are the results of a simulation model named AFRAMS (Air Force Rated Aircrew Management System) created in 2001. AFRAMS begins with a snapshot of the pilot inventory taken at the end of the fiscal year and simulates the major events and decisions during the career of an officer (HAF/A1PPR, 2011).

Table 1: High Year of Tenure Limits

Grade	Year 1	Year >= 2
2LT	10	10
1LT	10	10
CPT	14	14
MAJ	20	20
LTC	28	28
COL	30	30

This series of simulations requires the input of certain assumptions in order to generate the Blue Line. One of these assumptions is the High Year of Tenure (HYOT) limits given in Table 1 (HAF/A1PPR, 2011). These numbers reflect the maximum number of years an officer can be simulated to stay in the Air Force in the model. However, these numbers are subject to change as there is no guarantee of selective continuation and could be lowered in order to meet congressionally mandated end strength. Additionally, the historical promotion rates for each grade for above, below and in the zone officers are included into the simulation.

Table 2: Rated Distribution for UFT Production – Pilots

FY/Source	Fighter	Trainer	Bomber	Mobility		C2ISR	CSAR	SO	Unman	Total for Yr
2011	168	0	54	527	0	72	48	123	100	1092
2012	142	0	61	494	0	103	54	94	0	948
2013	140	0	63	572	0	93	75	78	0	1021
2014	154	0	63	555	0	92	74	74	0	1012
2015	164	0	65	554	0	99	73	74	0	1029
2016	164	0	71	534	0	104	62	77	0	1012
2017	164	0	71	533	0	104	51	76	0	999
2018	164	0	71	576	0	104	65	76	0	1056
2019	164	0	71	576	0	104	65	76	0	1056
2020	164	0	71	576	0	104	65	76	0	1056

Currently, the initial Active Duty Service Commitment (ADSC) for pilots upon completion of undergraduate flying training (UFT) is ten years. Along with the initial ADSC and HYOT inputs is the projected number of pilots produced for the next ten years. Table 2 shows that the current projections are for approximately one thousand pilots per fiscal year (HAF/A1PPR, 2011).

Along with the number of pilots, AFRAMS segments the pilots based on airplane categories as seen in Table 2. Under each of these pilot categories, historical retention data is used to project loss rates, either by voluntary means or from involuntary reasons such as death or loss of medical clearance to continue to fly. The model also includes an estimate on how many eligible pilots will take the ACP with a corresponding five year ADSC. Under the 2011 Blue Line model, there was a 65% take rate forecast for 2011, a 60% take rate for 2012, and 55% for every year thereafter (HAF/A1PPR, 2011).

Table 3: Pilot Loss Rates by Major Weapons System and Years of Service

Year of Service	FTR	BMR	MOB	C2ISR	CSAR	SO	UNMAN
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.1417	0.1204	0.1676	0.1933	0.0767	0.1012	0.1538
12	0.1285	0.0717	0.1612	0.1128	0.0769	0.0947	0.0997
13	0.1683	0.1003	0.2056	0.1570	0.1082	0.0828	0.1300
14	0.1579	0.0955	0.1434	0.1281	0.0714	0.0845	0.1127
15	0.0977	0.0408	0.0621	0.0680	0.0224	0.0552	0.0524
16	0.0567	0.0449	0.0517	0.0734	0.0282	0.0315	0.0474
17	0.0501	0.0645	0.0656	0.0478	0.0256	0.0108	0.0391
18	0.0381	0.0323	0.0373	0.0436	0.0000	0.0247	0.0262
19	0.0631	0.0781	0.0581	0.0663	0.0548	0.0377	0.0541
20	0.3769	0.3464	0.3920	0.3738	0.3183	0.3170	0.3462
21	0.3958	0.2793	0.2977	0.3674	0.2447	0.2517	0.3148
22	0.5010	0.4586	0.4546	0.3369	0.5244	0.4449	0.4790
23	0.6411	0.5952	0.4762	0.5556	0.4993	0.4697	0.5183
24	0.4069	0.4935	0.2923	0.3319	0.3092	0.5145	0.3817
25	0.4292	0.3120	0.3562	0.1944	0.3372	0.1667	0.2933
26	0.3419	0.2319	0.1622	0.3123	0.4167	0.2381	0.3142
27	0.3667	0.1778	0.3333	0.2222	0.2222	0.3333	0.3231
28	0.9048	1.0000	0.9048	1.0000	0.9167	0.7778	0.9287
29	0.6667	1.0000	1.0000	1.0000	1.0000	1.0000	0.9583
30	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Only pilots who are not on an ADSC are vulnerable to being removed from the simulation through voluntary means. It excludes those losses due to promotions to O-6, deaths and groundings, non-continuations and HYOT since these losses are handled separately in their own portion of the model logic. The numbers in Table 3 are based on the historical averages for pilots in each aircraft category from FY95 to FY05. Recent years have not been used so that multiple force shaping years do not skew the simulation (HAF/A1PPR, 2011).

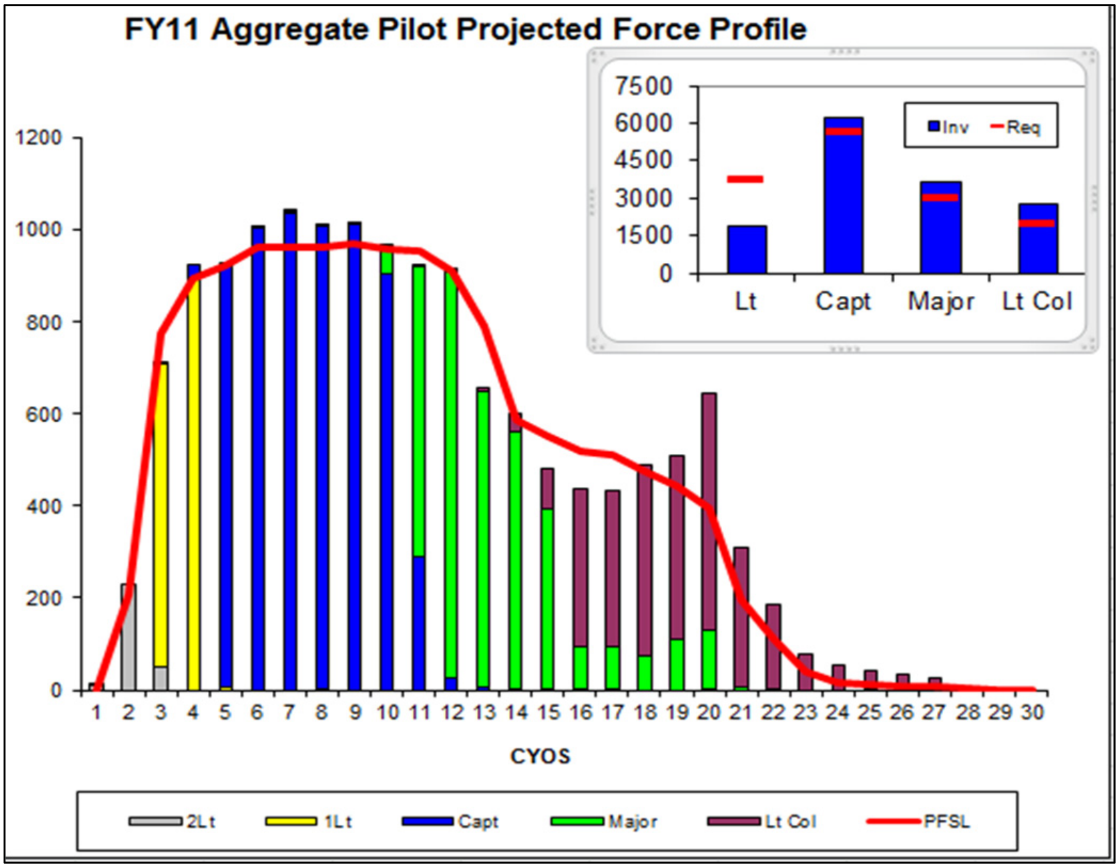


Figure 3: FY11 PFSL chart

Besides these estimates going into the creation of a RL/BL chart like in Figure 1, AFRAMS also creates a series of Projected Force Sustainment Line (PFSL) Charts for the next 10 years. The PFSL is created by looking at an inventory of pilots by commissioned years of service (CYOS). The PFSL takes the requirement and spreads it out among the CYOS categories according to the ratio that the model suggests the pilot inventory will be far into the future. The area under the PFSL illustrates the overall pilot requirements and the shape of the curve is due to the retention behavior of previous year groups. The inventory bars by CYOS are placed under the PFSL to visually see how the inventory conforms to the PFSL (HAF/A1PPR, 2011). In the FY12 PFSL chart, each year groups' projected numbers would be forecast and shifted over by one year to see how year groups with shortages or surpluses will be affected over time based on the assumptions placed into the model. The RL/BL chart in Figure 1 shows a 250 pilot surplus while the PFSL chart in Figure 3 shows most of that surplus to be in the 6 – 9 and 19 – 27 CYOS year groups. Depending on how the AFRAMS simulation models retention behavior in those year groups, the difference between the PFSL and the actual year groups could expand or contract.

Cumulative Continuation Rate

In addition to the RL/BL produced by the Air Staff, AFPC tracks and reports pilot retention is through a metric known as the CCR. The CCR measures the retention of pilots cumulatively through a specified range of commissioned years of service. A common display for CCR is for 6 to 14 years of commissioned service. For example a CCR of 65% means that 65% of the rated officers entering their 6th year of service are expected to remain on active duty at least to 14 years of service (AFI 11-412, 2009: 48).

However, CCR is not a predictive tool as it is currently computed. In fact, a CCR is simply the product of multiple year groups' simple retention rates. Simple retention (SR) is calculated as the number of flyers remaining at the end of a particular year of service (i.e. 6th year of service) group divided by the number of flyers that began that year. For example, if a year group started with 100 pilots and finished the year with 90 pilots, the SR for that year group would be .9 or 90%. The formula for CCR for pilots from 6 to 14 years would look like the following (AFI 11-412, 2009: 75):

Cumulative Continuation Rate (CCR) 6-14 =

SR 6YOS x SR 7YOS x …… x SR 14YOS

Equation 1: CCR Computation

Since CCR is simply a look at what is happening currently and in the past years, it offers no insight as to what may happen in the future. However, it does provide an ability to track trends to see if there is a need for concern over being able to retain enough pilots in order to meet the Red Line requirements.

Previous Research

CCR rates have been used by government agencies for some time to reflect pilot retention. The United States General Accounting Office (GAO) reported in 1998 to the US Senate Armed Services Committee that CCR had been 78 percent in 1983 but had dropped to 48 percent at the time of the report (USGAO, 1988:2).

The GAO also noted how quickly force structure projections could change rated forecasts. At the end of 1987, the Air Force had 23,300 pilots which accounted for a surplus of 58 pilots. However, from September 1987 to the release of the presidential budget for FY88, a shortage of pilots began to be projected with as many as two thousand pilots by the end of FY92. To counter these trends, the Air Force changed the initial service commitments from 6 years to 8 years after UFT (USGAO, 1988:18).

The Assistant Secretary of Defense, Mr. Grant S. Green, Jr., wrote that the Department of Defense concurred with all of the findings presented in the report to the Senate Armed Services Committee. The Department of Defense comments did note that the frequent changes to pilot requirements were due to changes stemming from the budgeting process (USGAO, 1988:33). Perhaps the most interesting part from this report is that, in a survey, pilots said the recent drawdown and tight fiscal environment was a part in the overall decline in pilot retention (USGAO, 1988:36).

Other research projects have found several contributing factors to affecting pilot retention. In 2003, Richard Fullerton from the US Air Force Academy completed an empirical assessment on pilot retention in the Air Force. This study used very specific individual demographics such as age, race, marital status and aircraft category as well as some economic factors such as the unemployment rate, deployment frequency, airline hiring as well as the disparity between military and civilian pay scales. The results of his study concluded that economic factors such as the strength of the US economy, pay differential and hiring by the major airlines contributed most to the decision to separate from the Air Force (Fullerton, 2003: 354).

A RAND report in 2004 attempted to model military pilots departure from the DoD. They interviewed members from each branch of service in order to determine factors that led to a decision to separate. Factors they identified from these interviews as possibly having an effect on retention included earnings opportunities in the civilian market, operational tempo, frequency of deployments, adequacy of flying hours available and the length of time it takes to become fully trained along with attitudes toward service leadership. Additionally, they included source of commission and marital status as independent variables in the model. This model found the airline hiring to be strongly associated with retention and bonus pay could help to counteract the effects of airline hiring (Elliott and others, 2004: 43).

However, ACP has recently come under criticism as being unnecessary. Lieutenant Colonel (then Major) Brian Maue wrote an article published in Air & Space Power Journal in 2008 titled "Why We Should End the Aviator Continuation Pay Bonus." In this article, he argued that the perceived pay gap between major airlines and military pilots had been effectively decreased to the point to where ACP was not effective in increasing retention rates. Lieutenant Colonel Maue counters the argument that the program pays for itself by stating that it needs to be definitively proven how many pilots are actually convinced to stay solely by the ACP. The theory that it costs millions to create a pilot versus spending $125 thousand to retain one would ring hollow if the only pilots accepting the bonus were those already planning on remaining on active duty (Maue, 2008: 103). The article also mentions the lack of airline hiring as a reason, but the hiring estimates of over a quarter of a million pilots in the next 20 years calls the validity of that argument into question today (Jones, 2011). Furthermore, Levy (1995: 39) points out that strong demand at the civilian airlines could raise wages, thereby increasing the pay gap and further decreasing retention rates for pilots.

Summary

The Air Staff uses the AFRAMS simulation model in order to determine the BL in order to track year groups of pilots to identify shortages and make policy decisions. Additionally, AFPC tracks CCR and ACP acceptance rates as a method of identifying trends in pilot retention. Both models use historical data as a basis for their solutions, but neither includes any data outside the Air Force in making its predictions. Neither model gives any insight into what external factors may lead to a pilot deciding to separate from active duty. Several independent studies have concluded that there are factors such as major airline hiring rates and others that do have an effect on retention.

III. Methodology

Chapter Overview

As stated previously, this research focuses on using historical data that is applicable to every pilot on active duty in the Air Force. This being the case, there was no attempt to get personnel data regarding individual factors such as the CCR based on number of dependents, age or airframe type. The data collected was taken using public sources so that no private information was collected during the research process.

To answer these research objectives, the data will be subjected to regression analysis in order to determine if there is any relationship to pilot retention. Regression analysis is defined as "the part of statistics that deals with investigation of the relationship between two or more variables related in a nondeterministic fashion" (Devore, 1995:474). The name of the data set used in the models will be put in parentheses after the title for each section. For this analysis, CCR will be the independent variable and all other variables will be dependent variables that will be tested for statistical significance to the independent variable. The retention statistics in Table 3 show that pilot retention after the fifteen year point tends to be very high, most likely from the short time frame from earning retirement benefits from a twenty year career. After twenty years of service, the retention noticeably decreases as the retirement benefits have already been secured. With this in mind, CCR becomes the logical choice for the independent variable since pilots who stay in past the fourteen years of service are more than likely to stay until twenty years of service (AFPC/DPAPA, 2011). The data used for all of these dependent variables from 1998 to 2011 can be found in Appendix B.

Aviator Continuation Pay (ACPrate)

One of the first variables to be examined is what percentage of eligible pilots took aviator continuation pay when reaching the end of their initial ADSC for UFT, with the variable being called ACPrate in SPSS. This data is made available through the AFPC retention reports along with the CCR. ACP became available in 1989 after a six year ADSC for UFT at a rate of $12,000 per year to those available to extend their service for seven additional years (Stone and others, 1998:132). The program has since expanded to offering $25,000 to pilots for an additional five years after their initial ADSC in 2012 (AFPC/DPAPA, 2011). It should be noted that ACP is a year-to-year program that can change based on Blue Line predictions as well as changes in the fiscal environment. Conflicting views on whether the ACP is still necessary or financially viable under the recent fiscal constraints make ACP a valuable addition to the model to test the ACP's validity on retention.

National Unemployment Rates (Unemployed)

Since 2002, the United States has weathered some hard economic times. The federal government has provided federal aid to banking and automotive industries in order to keep too many Americans from suddenly becoming unemployed or losing their life savings. Active duty pilots considering separating from the Air Force and joining the commercial sector would have to judge their likelihood of employment when making the decision to remain in the military. The historical data on national unemployment was readily available from the Bureau of Labor Statistics website and showed that the unemployment rate for the last 3 years was worse than any other period since the late 1940's (Bureau of Labor Statistics, 2012b).

Annual Airline Hires (PilotHires)

Closely linked to the national unemployment is the rate at which commercial air carriers are hiring. While certainly not their only skill set, the idea of continuing to build on their flying experience is appealing to a number of pilots, especially those looking to continue their service in the Guard and Reserve. Since previous studies found airline hiring to be linked to pilot retention, the number of annual airline pilot hires was included in the model and made available through the CyberCompass Corporation (2012).

One interesting fact posted on www.fltops.com was that over the last 22 years; over 47,000 pilots had been hired by the national airlines (CyberCompass Corporation, 2012). However, USA today reported that North American airlines were expecting to hire nearly 100,000 pilots over the next 18 years (Jones, 2011). With the demand for pilots expected to nearly double and previous studies showing that airline hires have been significant in pilot retention, annual airline hiring rates are a logical addition to the model to test their significance in determining CCR.

Average Airline Salary (Mean_Salary)

Tied to airline hiring, the salaries that the airline pilots are making in comparison to their military counterparts have been used as justification for ACP. It is important to note that airline salaries have not risen at the rate of inflation in recent history. For example, American Airlines pilots' salaries have actually decreased from 1999 to 2008.

This is in stark contrast to other professions in that same period (Allied Pilots Association, 2010:13).

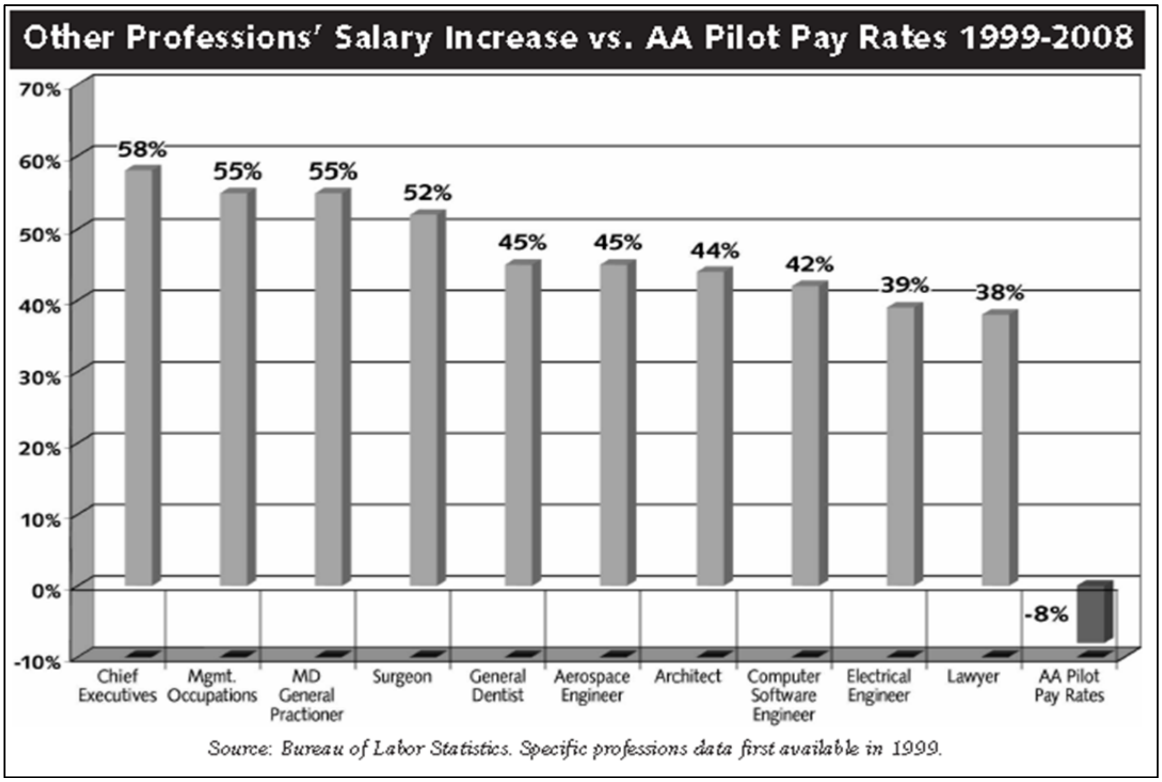


Figure 4: Comparison of various US occupations' salaries

According to the Bureau of Labor Statistics, the average salary for a commercial airline pilot in 1999 was $98,280. However, the average salary for 2008 was $119,750 and decreased to $115,300 by 2010 (Bureau of Labor Statistics, 2012b). Adjusted for inflation, that salary would be $127, 010 in 2008 and $128,635 by 2010, a difference of over seven and eleven thousand dollars, respectively (Bureau of Labor Statistics, 2012a). The difference between airline pilot wages and inflation can be seen in the figure below (MyPlan, 2012):

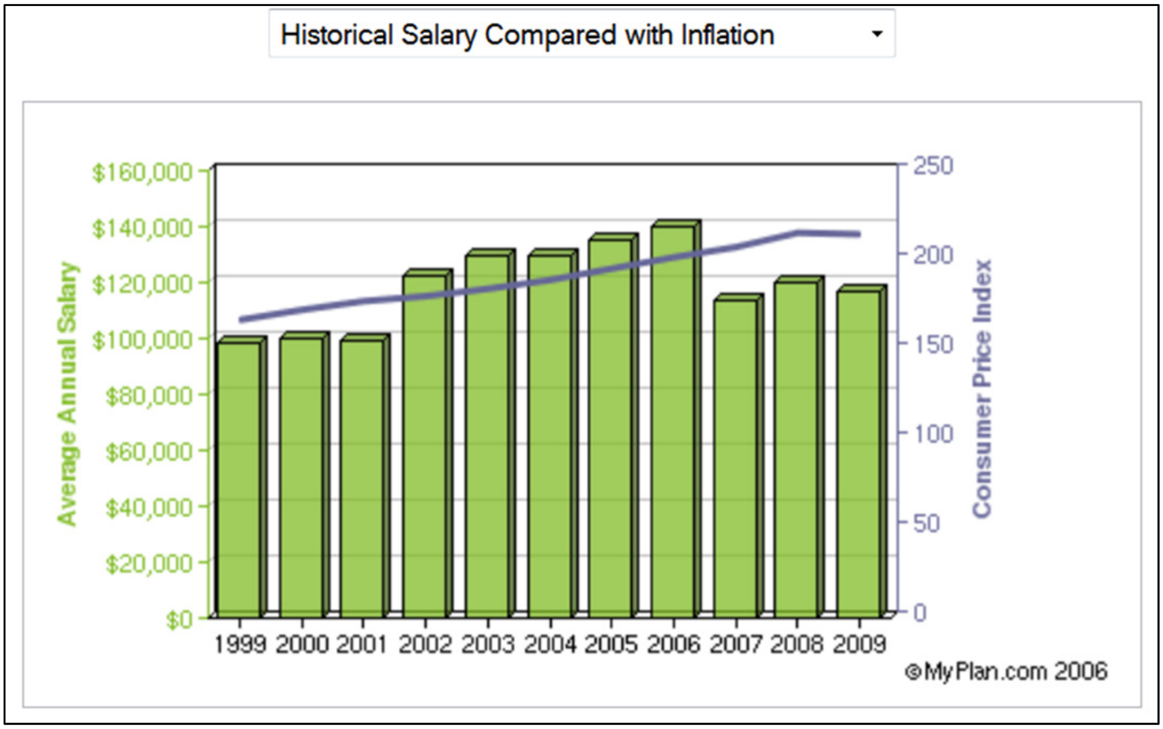


Figure 5: Airline salaries compared to inflation

Comparatively, the average base pay of a Major with 10 years of service in 2009 was over 56% higher from 1999 to 2009, compared to the 15% seen by major airlines pilots (Military.Com, 2012). It is not possible to truly measure the pay gap over the time by including benefits, as factors such as pensions and healthcare have changed over the last decade as airlines have gone through bankruptcy reorganization. However, military pilots are able to look at their commercial aviation counterparts to judge whether the overall difference in pay and benefits is enough to entice them to separate. By adding the average major airline salary as reported by the Bureau of Labor Statistics into the model, it can be determined if the shrinking pay gap does indeed have an effect on retention.

Force Shaping (ForceShape)

From 2002 to 2011, the CCR for 2007 was over 20 percent lower than the next lowest year in that span. The reason for that is the existence of force shaping initiatives that allowed certain year groups of pilots to leave prior to their initial ADSC for UFT. AFPC noted in their rated retention reports that the existence of offering VSP would cause an initial dip in CCR but then lead to higher CCRs in later years as pilots who had no intention of staying on active duty after their initial ADSC were already removed from the equation (AFPC/DPAPA, 2011).

Since force shaping initiatives were only offered in 2006 and the results seen in FY07, the variable ForceShape was included in the model as a binary variable. Data was entered strictly as a zero for every year except 2007 where it was entered as a one in order to show the existence of the possibility of pilots leaving service prior to their initial ADSC. With only one data point, it is not statistically possible to use any model that includes force shaping as a variable and to effectively predict what will happen during the next round of force shaping. This is especially true when you consider that the conditions under which pilots may be offered VSP or another force shaping program may change each fiscal year. For example, there was a limit to the number of pilots who were approved for VSP in each year group in 2007 (AFPC/DPAPA, 2011). In 2012, there were only 25 VSP applications approved but the RIF board took an additional 199 pilots and separated them (Ricks, 2011). Due to the variable nature of force shaping initiatives, the best a model can do is effectively tell how past force shaping years affected CCR if it proves to be statistically significant.

Marriage Rate (Married)

According to statistics released by the Department of Defense, divorce rates among service members have risen from 2.6 to 3.7 percent from the start of combat operations in Afghanistan in 2001 up to 2011 (Bushatz, 2011). The effect of numerous deployments and increased operational temporary duties away from home station (TDYs) can have a negative impact on service members and their relationships. Studies have shown that service members who were married actually had better retention during times of multiple deployments than members who were not deployed (Elliott and others, 2004: 40). Using the AFPC Interactive Demographic Analysis System (IDEAS) website, it is possible to determine the marriage, divorce, separation and annulment status of all pilots (AFPC, 2011). For this purpose of the study, the data for pilots with less than 11 years of commissioned service was taken. Unfortunately, the data was not available to determine how many pilots there were who had divorced previously but then had remarried. The percentage of pilots who were currently married at the end of each fiscal year was used to determine how feasible it was to maintain a relationship despite the continuous deployments. By adding this data into the model, the effect of the increased operations tempo on a pilot's ability to either cultivate or maintain a relationship has had an effect on their retention.

Time away from home (TDYrate)

Studies by Fullerton and reports by the GAO have listed deployments and operations tempo as reasons for dissatisfaction. The Air Force defines PERSTEMPO as the days per year one spends away from home on temporary duty (AFPC, 2011).

PERSTEMPO has been on the rise in the past decade and could be a leading indicator on retention rates. The TDY rates for all pilot AFSCs, starting with 11-, are available on the AFPC Secure Applications page under the PERSTEMPO link (AFPC, 2011). These rates were put in the model as average number of days TDY in a given calendar year.

Promotion Factors (nonSOSres & O5Promotion)

The last two factors included in the models are ones that are directly involved with the ability for career advancement. The RIF board in 2011 cut 199 pilots from active duty while in the summer of 2011, 157 majors who were passed over to Lt Col for a second time were not offered selective continuation and had to separate by 30 November. According to the article in the Air Force Times, the practice of non-continuation may continue until such time as the Air Force can meet end strength goals (Larter, 2011).

Pilots have not been vulnerable to involuntary separations of this nature since the drawdown of the mid-1990's. Because of this, pilots may be looking to certain factors to determine their ability to remain on active duty in the future should they decide to remain. Concerns over their ability to be allowed to stay until twenty years and earn their retirement benefits may force some pilots to decide to join the airlines earlier rather than risk being separated and having no retirement benefits to show for it.

Promotion statistics have shown that Captains who have attended Squadron Officer School (SOS) in residence have higher promotion rates than those who do not attend. In 2011, pilots who attended SOS in residence had a 37.5% better chance at being promoted than their counterparts who did not attend. Similarly, with only a 75% rate for being promoted to Lieutenant Colonel in 2011, pilots must weigh the risks of being passed over for the next rank and possibly facing separation (AFPC/DSYDT, 2012). The SOS attendance rates as well as the promotion rates to Lieutenant Colonel from the AFPC Static Reports webpage were added to the model in order to test for significance (2012).

Summary

Based on previous research regarding Air Force Pilot retention and current events, nine dependent variables were chosen for examination of statistical significance in predicting CCR. Like the BL computations, the model will take into account the fluctuations in promotion rates as well as force shaping initiatives. Attending SOS is a distinguishing mark on an officer's career and the model can ascertain whether fluctuations in attendance have played a factor in pilots determining to remain on active duty. Additionally, the model will look at the effect that marriage rates and PERSTEMPO have on a pilot's personal life and their career decisions. Finally, the model will look at economic factors such as the national unemployment rate, the pay gap between the commercial and military pilots, ACP and airline hiring rates to see what role they play in retention.

IV. Analysis and Results

Chapter Overview

For this experiment, the hypothesis is that a predictive model can be used to determine future CCR values in the 6 – 14 year groups. Data was retrieved from a number of different sources to cover a fourteen year period, 1998 – 2011. The data sets we chose to examine included Aviator Continuation Pay take rates, airline hiring statistics and average pay, TDY rates, promotion statistics to Lt Col as well as statistics for those who do not attend Squadron Officer School in residence, percentage of pilots who are married, the presence of Force Shaping and national unemployment rates.

All of these statistics were Air Force pilot specific except for the national unemployment rate and the promotion rate for pilots to Major for those who did not attend SOS, as these statistics were unavailable. It was assumed that all results collected were normally distributed. Using this data, forward, mixed and backward stepwise regression models were calculated to determine which, if any, of these models would prove to be most useful.

Results of Simulation Scenarios

A forward stepwise regression was performed on the data using SPSS. After only one iteration, only one variable was found to have a $p<.05$. The regression indicated the only significant independent variable to be the dummy variable PilotHires representing the number of pilots hired by the airlines in a given year. The mixed stepwise regression model ended up mirroring the forward stepwise regression model in results.

The forward and mixed stepwise regression equation is:

Predicted CCR = - .011 * PilotHires + 76.893

Equation 2: Forward/Mixed Stepwise Regression Equation

There are multiple ways to assess the accuracy of this model, to include (See Appendix C, Tables 2-5):

- Global F-test
- Interpret adjusted R^2
- T-test on most important β's

This model was assessed using the SPSS software package. F was calculated at 74.875. F_α (v1=k=1, v2=n-(k+1)=12) is 4.75 at α=.05. Since $F > F_\alpha$, we can reject the hypothesis that all β's = 0 and conclude that at least one of the coefficients is not zero. For this model, adjusted R^2 = .850. Thus, we can say that using the variable PilotHires accounts for 85% of the total sample variation. Finally, a two-tailed t-test tests the null hypothesis that $\beta = 0$. Rejection indicates that the alternative, $\beta \neq 0$, should be accepted. In this case, degrees freedom = n-(k+1) = 12, $t_{.05/2} = 2.179$. The absolute value of the t-statistic for the included variable is considerably larger than critical t.

To assess the effectiveness of this model, the residuals must be assessed. There are several properties we should find are characteristic of the random error, ε.

- Normal probability distribution
- Mean equal to zero
- Constant error variance

Figure 7 in Appendix C shows the histogram of the forward and mixed stepwise regressions for confirmation that the distribution is normal. With no outliers beyond 3 standard deviations, this histogram seems to confirm the distribution is normal. Further analysis of the standardized residuals confirms the mean is 0.

Figure 8 in Appendix B is the SPSS scatterplot for evidence of patterns, such as any clear increases/decreases in the residual that correspond to the predicted value. If it were clear that there were increases or decreases in the residual that correspond to the predicted value, it might be necessary to apply a variance-stabilizing transformation on the dependent variable (logarithmic, quadratic, etc.). In this model, more samples would be required to conclusively determine if a pattern were present. However, initial data suggests there is no pattern, negating the need for a variance stabilizing transformation.

For comparison, a backward stepwise regression was also performed on the data using SPSS. After six iterations, three variables remained with $p<.1$. The regression indicated the significant independent variables to be the dummy variables ForceShape, ACPrate, and PilotHires.

The backward stepwise regression equation is:

Predicted CCR =

-19.871 * ForceShape + .522 * ACPrate - .007 * PilotHires + 39.317

Equation 3: Backward Stepwise Regression Equation

This model was also assessed using the SPSS software package. F was calculated at 86.490. F_α (v1=k=1, v2=n-(k+1)=12) is 4.75 at α=.05. Since $F > F_\alpha$, we can reject the hypothesis that all β's = 0 and conclude that at least one of the coefficients is not zero. For this model, adjusted $R^2 = .952$. Thus, we can say that using the variables PilotHires, ForceShape and ACPrate can account for 95.2% of the total sample variation. Finally, a two-tailed t-test tests the null hypothesis that $\beta = 0$. Rejection indicates that the alternative, $\beta \neq 0$, should be accepted. In this case, degrees freedom = n-(k+1) = 12, $t_{.05/2} = 2.179$. The absolute value of the t-statistic for the included variable is again considerably larger than critical t (See Appendix D, Tables 6-8).

Figure 9 in Appendix D shows the histogram of the backward stepwise regression for confirmation that the distribution is also normal. With no outliers beyond 3 standard deviations, this histogram seems to confirm the distribution is normal. Further analysis of the standardized residuals confirms the mean is 0.

Figure 10 in Appendix D is the SPSS scatterplot for evidence of patterns, such as any clear increases/decreases in the residual that correspond to the predicted value. Again, there was no obvious pattern to suggest the need for a variance stabilizing transformation. In this model, more samples would also be required to conclusively determine if a pattern were present.

Summary

Having done a forward, mixed and backward stepwise linear regression of the data, the backward stepwise model provided the best results with an adjusted R^2 value of just over 95%. All other variables were eliminated, indicating that the 6 – 14 year cumulative continuation rate can best be predicted by changes to:

- **Existence of an active force shaping program**. This is not surprising as the 2007 program paid hundreds of junior pilots (<10 years) up to \$100,000 to depart active duty. It should be expected that the VSP and RIF of FY12 will have a negative effect on the CCR for 2012.

- **Aviation Continuation Pay (ACP) acceptance rate.** This factor barely missed passing the T test for the forward and mixed stepwise regression. Currently, ACP incentivizes pilots to commit to 3 to 5 additional years of active duty in exchange for $125,000 (Laster and others, 2012:22). Pilots become eligible for ACP upon expiration of their initial UPT service commitment, which typically occurs around 11-13 years of aviation service. Accepting ACP thus secures the services of these pilots for at least 15 years of service. For this study, it can be assumed that most pilots who reach 15 years of service will remain on active duty until at least the 20th year due to the influence and proximity of retirement pay.
- **Increased pilot-hire rates in the civilian aviation segment.** As a review of the regression data will indicate, this is the most significant predictor (in both models discussed here) of pilot retention. Flying in the private sector is attractive to pilots for many reasons, even though the pay has been relatively stagnant. Throughout the late 1990s, the commercial industry was relatively healthy. The impact on Air Force pilot manning is evident by noting the low CCR figures during this time. The 9/11 attacks and subsequent industry downturn reduced opportunities for Air Force pilots to transition to civilian flying and the data suggests that CCR was positively affected as a result.

V. Conclusions and Recommendations

Conclusions of Research

The research concluded that only three factors that apply to all active duty pilots were significant in regards to predicting retention. It was surprising that some factors such as national unemployment levels were not found to be statistically significant based on the regression models. The fact that airline hiring was statistically significant where national unemployment was not suggests that pilots tend to prefer to continue in their aviation duties when leaving active duty if possible.

Significance of Research

This model could be useful for HAF planners who must "lead-turn" pilot retention trends so the future force has the most advantageous balance of experience. Given the length of time and expense required to produce an experienced aviator, leadership should be cognizant of those factors which influence retention behavior. In this example, there proved to be few internal factors which affected CCR. Surprisingly, TDY and promotion rates do not appear to be influential. Instead, one model accurately predicted retention solely on the basis of pilot hiring in the commercial sector while the backward stepwise model detected that the ACP-take rate was significant. This suggests that AF leaders can influence retention by taking actions to make ACP more attractive to aviators. Even if the AF is victimized by circumstances beyond its control, the model still has value since future civilian pilot hiring is generally forecast years in advance. Having these forecasts in hand, planners can be proactive by enhancing ACP or increasing pilot production to head off potential losses rather than reacting afterwards and create a potential shortage in experienced pilots.

Recommendations for Action

Using the forward and mixed stepwise regression model's equation for predicted CCR, planners can then use some forecasting numbers to determine the potential CCR for future years. Based on the USA Today article, approximately five thousand pilots a year will be hired by the major airlines over the next eighteen years (Jones, 2011). The last time the airlines hired that number of pilots in a single year was in 2000, right before the attacks of September 11 that led to reduced air travel for several years and put a financial strain on the airline industry (CyberCompass Corporation, 2012). In 2000, the ACP acceptance rate was 32.1 percent (AFPC/DPAPA, 2011). Using these numbers in the predictive equation while assuming there are no active force shaping programs:

$$\textit{Predicted CCR} = -19.871 * (0) + .522 * (32.1) - .007 * (5000) + 39.317 = \underline{21.0732}$$

Equation 4: Predicted CCR (5000 hires and 32.1% ACP rate)

Looking at Figure 3, you can see from the PFSL that the number of pilots is approximately one thousand in the 6 CYOS group and the PFSL needs nearly six hundred to meet sustainment. From the equation above, it is apparent that this predicted CCR does not come close to meeting this goal, predicting just over two hundred pilots by the 14 year point. However, Air Staff projection numbers that are applied into the Blue Line calculations can also be applied to the equation in order to tell what the model would predict given their planning numbers. For 2013 and beyond, the Air Staff uses a 55%

baseline for ACP acceptance rate. Even with that increased take rate and only half of the projected airline hires, the predicted CCR for 2014 would still be just over 50%.

$$\textit{Predicted CCR} = -19.871 * (0) + .522 * (55) - .007 * (2500) + 39.317 = \underline{50.527}$$

Equation 5: Predicted CCR (2500 hires and 55% ACP rate)

In both scenarios, the USAF cannot expect to have the sustainment number of pilots at the 14 CYOS with the Air Force's current production rates of just over one thousand pilots per year.

To date, the ACP acceptance rate for FY12 has been underwhelming and could be a possible harbinger of retention problems to come. The FY12 ACP program was announced in March 2012 and applicants for the bonus have until 30 September 2011 to apply. Table 3 shows the acceptance rate after the first month of the 6 month eligibility window (AFPC/DSYDT, 2012).

Table 4: Summary of ACP Agreements Finalized as of 24 Apr 12

		Contract Option								TOTAL	
		Initial 5yr		Initial 5yr-50%		NonTaker		Uncommitted 3yr			
Rating	**Eligibles**										
NAV	**Initial**	13	37.14%	0	0	22	62.86%	0	0	35	100.00%
	Uncommitted	0	0	0	0	4	100.00%	0	0	4	100.00%
PLT	**Initial**	106	12.79%	29	3.50%	694	83.72%	0	0	829	100.00%
	Uncommitted	0	0	0	0	42	97.67%	1	2.33%	43	100.00%

Based on the results of these models, the Air Staff needs to closely examine airline trends as they do with ACP take rates. These forecasts concur with the findings of RAND in 2004 that suggested that the Air Force forecast on retention needs to incorporate major civilian airline hiring (Elliott and others, 2004:43). Incorporating airline hiring predictions into the creation of the BL could lead to better forecasts. If the airlines do indeed begin hiring by the thousands and ACP take rates decrease as a result, then either the ACP needs to be expanded in order to entice retention or the pilot pipeline needs to be increased in order to create more pilots to replace those who choose to separate.

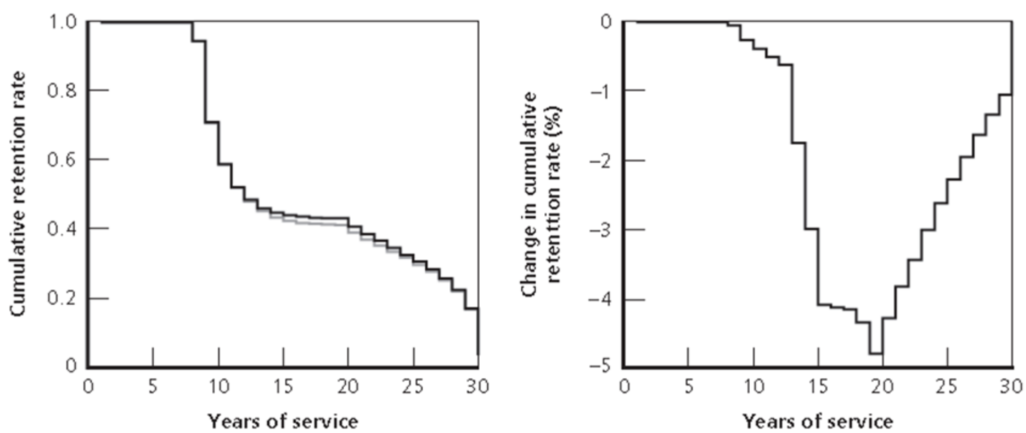
Recommendations for Future Research

As mentioned previously, it takes a lot longer to train a new pilot than it does to remove one from service through force shaping measures. As such, it is imperative that the DoD and USAF are cautious when making pilots vulnerable to force shaping measures. From the model, we can see that force shaping measures can affect CCR by nearly 20%. If the Air Staff goal for CCR from 6-14 years of service is to retain close to 60%, force shaping alone would account for almost half of the desired losses.

However, this is based on one data point and does not take into account the effects of the 2011 force shaping programs since those pilots were not separated until FY 2012. In order to better refine the model, future years should be incorporated into the model in order to better gauge the effects of force shaping policies. Additionally, it's worth trying to uncover the necessary data to incorporate years prior to 1998 into the model in an attempt to possibly refine the model further.

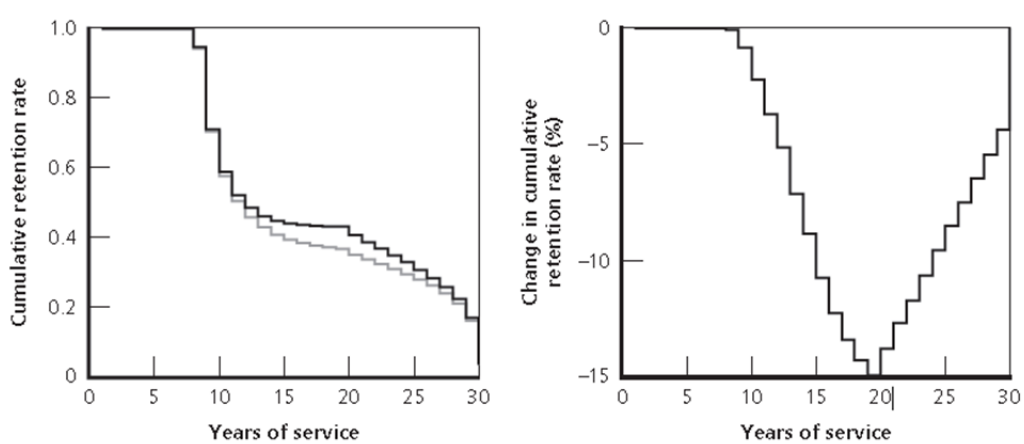
In addition to adding future data points, another point of future research would be examining the effect of modifying incentive programs such as the ACP, retirement or medical benefits. In 2011, the GAO recommended that the Secretary of Defense conduct research to determine optimal bonus rates for all services, to include ACP (USGAO, 2011:26). An example of such research would be a RAND study completed in 2007 that detailed the removal of the bonus that lasted until twenty years of service as well as also detailing the predicted retention change if the bonus was discontinued (Mattock, 2007:21).

Simulated Effect of Eliminating the 20-Year Option for Pilots



RAND TR470-4.5

Simulating Elimination of the ACP Program for Pilots



RAND TR470-4.6

Figure 6: Modifications to the ACP program

According to the results of the RAND simulations, the elimination of the ACP could have as much as a nine percent change on CCR through fourteen years and a fifteen percent change in CCR by the 20 year point as seen in Figure 6 (Mattock and Arkes, 2007:21). To avoid future bullwhip type effects, additional studies on the effects of any changes to benefits may pay dividends in regards to avoiding unforeseen consequences to overall pilot manning.

Summary

In 1999, the GAO surveyed a number of pilots who were leaving active duty and reported this:

> These pilots have "grown up" in a military environment in which they have seen separation incentives, 15-year retirements, and forced early retirements after 20 years of service. They do not see the military as a guaranteed job. Air Force pilots, in particular, raised concerns that they are being sent back to junior flying positions and not getting assignments to the traditional military leadership positions…On the one hand, the Air Force is reassigning pilots to cockpit positions; on the other hand, the promotion boards still expect the pilots to gain staff and education experiences to be competitive for promotion. (USGAO, 1999:13)

Nearly 15 years later, pilots are seeing some of the same things that the GAO reported. If the fighter pilot shortage that the Air Force Times reported on in April 2012 continues, remaining fighter pilots will be denied the ability to continue to fill career broadening assignments such as staff and ALO. Other pilots will be asked to fill these jobs regardless of the fact that they do not have the same experience to bring to the task, which could very well lead to job dissatisfaction. The training pipeline needs to be adjusted to at least account for the approximately 300 fighter pilots needed for sustainment as well as potentially increasing total pilot accessions to counteract potentially lower retention.

On top of this, factor in a projected hiring boom by the airlines, discussions on reducing retirement and medical benefits as well as the possibility of not selectively continuing if passed over for Lieutenant Colonel and it's entirely possible that the Air Force could be facing a retention problem in the near future. While the RL/BL and CCR have been good at giving insight to what the pilot inventory may look like, they are both based on historical averages and best guesses in regards to retention. The Air Force needs to study the effects of changing the ACP benefit before acting as well as incorporating major airline hiring projections into its forecasting in order to better predict pilot retention.

Appendix A: Acronyms

ACP – Aviator Continuation Pay

ADSC – Active Duty Service Commitment

AFPC – Air Force Personnel Center

AFRAMS – Air Force Rated Aircrew Management System

ALO – Air Liaison Officer

CAF – Combat Air Forces

CCR – Cumulative Continuation Rate

CYOS – Commissioned Years of Service

HYOT – High Year of Tenure

MAF – Mobility Air Forces

OSD – Office of the Secretary of Defense

PFSL – Projected Force Sustainment Line

RIF – Reduction in Forces

RL/BL – Red Line/Blue Line

RPA – Remotely Piloted Aircraft

SERB – Selective Early Retirement Boards

SOS – Squadron Officer School

SR – Simple Retention

TDY – Temporary Duty

UFT – Undergraduate Flying Training

VSP – Voluntary Separation Pay

Appendix B: Data Input into SPSS

Table 5: SPSS Data Inputs

Year	CCR	ForceShape	ACPrate	Married	nonSOSres	PilotHires	Unemployment	TDYrate	O5Promotion	Mean_Salary
2011	74.90	0	69.70	69.00	57.57	748.00	8.90	78.00	75.30	115300.00
2010	79.80	0	76.50	68.90	55.26	408.00	9.60	80.50	76.30	115300.00
2009	67.00	0	65.30	68.30	70.15	30.00	9.30	77.60	75.70	117060.00
2008	62.50	0	68.00	68.10	65.87	1299.00	5.80	80.60	74.90	119750.00
2007	35.80	1	66.90	68.20	67.03	2766.00	4.60	76.90	77.40	113940.00
2006	56.90	0	66.30	67.20	61.33	2443.00	4.60	78.10	73.90	140000.00
2005	57.60	0	65.10	65.80	63.93	2301.00	5.10	80.60	72.90	135000.00
2004	73.90	0	69.60	64.90	60.12	1199.00	5.50	75.90	70.40	129880.00
2003	62.00	0	65.30	65.10	59.93	854.00	6.00	84.90	64.00	129880.00
2002	61.50	0	46.80	66.00	53.74	851.00	5.80	70.20	67.80	122230.00
2001	31.00	0	29.90	65.40	53.33	3408.00	4.70	56.60	71.20	99400.00
2000	24.00	0	32.10	68.00	71.62	5105.00	4.00	55.40	67.90	99700.00
1999	26.30	0	42.00	70.50	62.35	4721.00	4.20	61.80	70.11	98280.00
1998	31.60	0	28.00	72.90	56.82	3511.00	4.50	64.70	72.30	98000.00

Appendix C: Forward/Mixed Stepwise Regression Tables

Table 2: SPSS Output for Global F-Test

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4224.597	1	4224.597	74.875	.000[a]
Residual	677.063	12	56.422		
Total	4901.660	13			

a. Predictors: (Constant), PilotHires

b. Dependent Variable: CCR

Table 3: SPSS Output for Adjusted R^2

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	928[a]	.862	.850	7.51145

a. Predictors: (Constant), PilotHires

b. Dependent Variable: CCR

Table 4: SPSS Output for Two-Tail T Tests (included variables)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	76.893	3.395		22.647	.000	69.496	84.291
	PilotHires	-.011	.001	-.928	-8.653	.000	-.014	-.008

a. Dependent Variable: CCR

Table 5: SPSS Output for Two-Tail T Tests (excluded variables)

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ForceShape	-.152[a]	-1.479	.167	-.407	.987
	ACPrate	.295[a]	2.071	.063	.530	.446
	Married	-.040[a]	-.344	.737	-.103	.900
	nonSOSres	-.014[a]	-.122	.905	-.037	.952
	Unemployment	.081[a]	.442	.667	.132	.369
	TDYrate	.169[a]	.961	.357	.278	.374
	O5Promotion	.018[a]	.159	.876	.048	.946
	Mean_Salary	.200[a]	1.603	.137	.435	.654

a. Predictors in the Model: (Constant), PilotHires

b. Dependent Variable: CCR

Forward and Mixed Stepwise Regression Charts

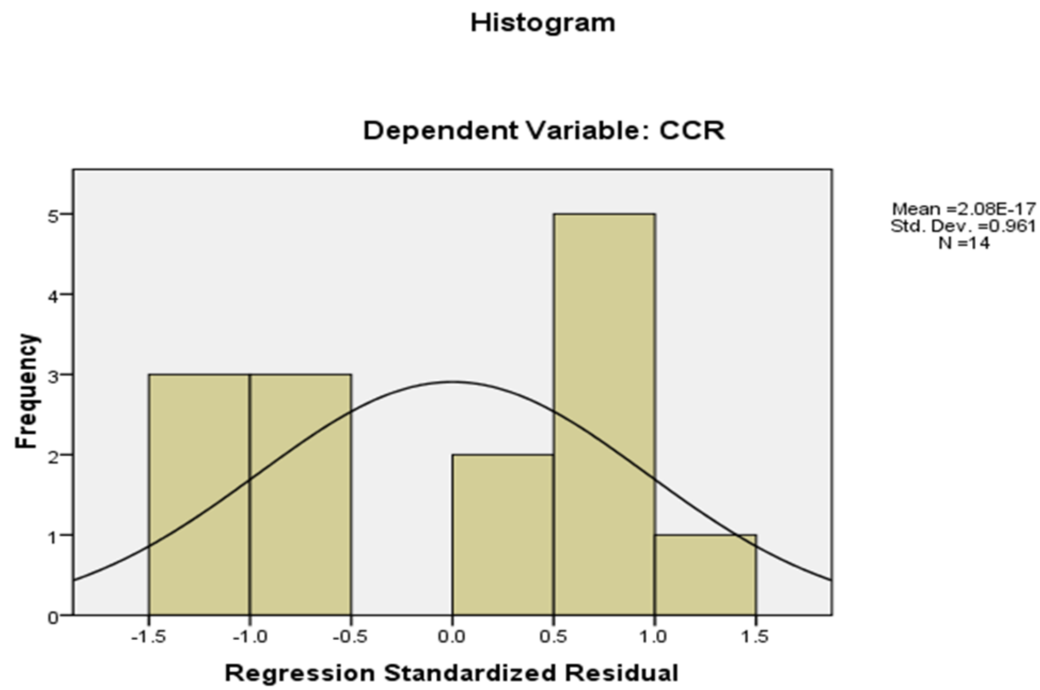


Figure 7: Forward/Mixed Stepwise Regression Histogram

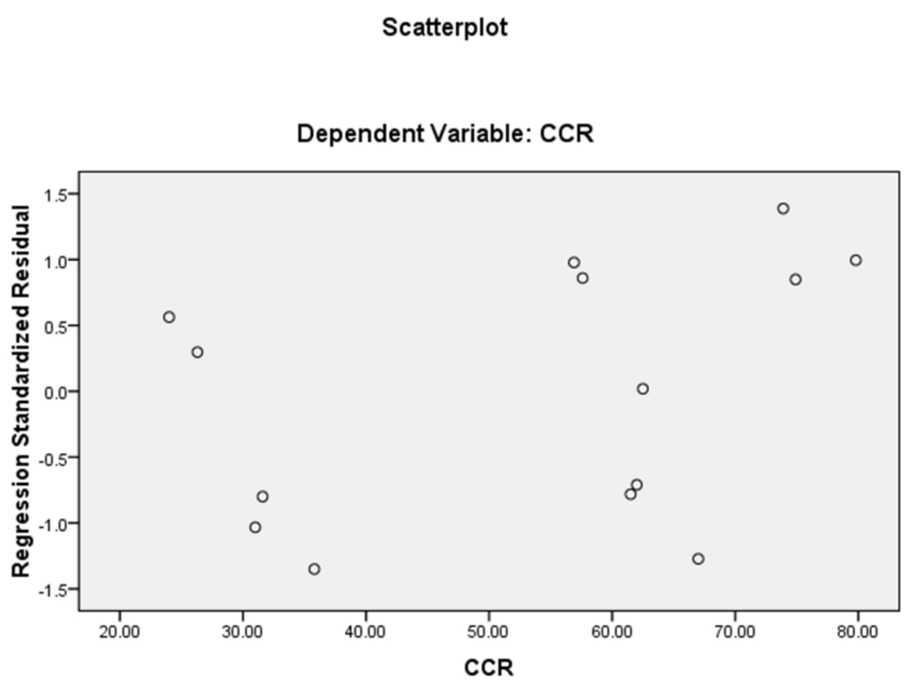


Figure 8: Forward/Mixed Stepwise Regression Scatterplot

Appendix D: Backward Stepwise Regression Tables

Table 6: SPSS

Output for Global F-Test

ANOVA[h]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4813.670	9	534.852	24.314	.004[a]
	Residual	87.990	4	21.997		
	Total	4901.660	13			
2	Regression	4813.596	8	601.699	34.163	.001[b]
	Residual	88.064	5	17.613		
	Total	4901.660	13			
3	Regression	4809.534	7	687.076	44.748	.000[c]
	Residual	92.126	6	15.354		
	Total	4901.660	13			
4	Regression	4796.295	6	799.383	53.108	.000[d]
	Residual	105.365	7	15.052		
	Total	4901.660	13			
5	Regression	4789.032	5	957.806	68.033	.000[e]
	Residual	112.628	8	14.078		
	Total	4901.660	13			
6	Regression	4756.840	4	1189.210	73.905	.000[f]
	Residual	144.820	9	16.091		
	Total	4901.660	13			
7	Regression	4719.760	3	1573.253	86.490	.000[g]
	Residual	181.900	10	18.190		
	Total	4901.660	13			

a. Predictors: (Constant), Mean_Salary, O5Promotion, nonSOSres, ForceShape, Unemployment, Married, ACPrate, PilotHires, TDYrate

b. Predictors: (Constant), Mean_Salary, O5Promotion, nonSOSres, ForceShape, Married, ACPrate, PilotHires, TDYrate

c. Predictors: (Constant), Mean_Salary, nonSOSres, ForceShape, Married, ACPrate, PilotHires, TDYrate

d. Predictors: (Constant), Mean_Salary, nonSOSres, ForceShape, ACPrate, PilotHires, TDYrate

e. Predictors: (Constant), nonSOSres, ForceShape, ACPrate, PilotHires, TDYrate

f. Predictors: (Constant), nonSOSres, ForceShape, ACPrate, PilotHires

g. Predictors: (Constant), ForceShape, ACPrate, PilotHires

h. Dependent Variable: CCR

Table 7: SPSS Output for Adjusted R^2

Model Summary[i]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.991[a]	.982	.924	5.36731	.982	16.715	0		.020	
2	.991[b]	.982	.942	4.67122	.000	.030			.874	
3	.991[c]	.982	.953	4.19677	.000	.036			.859	
4	.991[d]	.981	.959	3.91846	-.001	.231			.651	
5	.989[e]	.979	.960	3.87971	-.003	.862			.389	
6	.988[f]	.977	.963	3.75213	-.001	.483			.510	
7	.985[g]	.970	.957	4.01137	.007	2.287			.169	
8	.981[h]	.963	.952	4.26497	-.008	2.304			.163	2.537

a. Predictors: (Constant), Salary_Diff, PilotHires, ForceShape, nonSOSres, Married, O5Promotion, ACPrate, Unemployment, TDYrate, Mean_Salary

b. Predictors: (Constant), Salary_Diff, PilotHires, ForceShape, nonSOSres, Married, O5Promotion, ACPrate, TDYrate, Mean_Salary

c. Predictors: (Constant), PilotHires, ForceShape, nonSOSres, Married, O5Promotion, ACPrate, TDYrate, Mean_Salary

d. Predictors: (Constant), PilotHires, ForceShape, nonSOSres, Married, ACPrate, TDYrate, Mean_Salary

e. Predictors: (Constant), PilotHires, ForceShape, nonSOSres, ACPrate, TDYrate, Mean_Salary

f. Predictors: (Constant), PilotHires, ForceShape, nonSOSres, ACPrate, TDYrate

g. Predictors: (Constant), PilotHires, ForceShape, nonSOSres, ACPrate

h. Predictors: (Constant), PilotHires, ForceShape, ACPrate

Table 8: SPSS Output for Two-Tail T Tests (included variables)

Coefficients[a]

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
(Constant)	0.190	8.334		.442	.681	-159.536	19.917					
PilotHires	-.008	.003	-.639	-2.632	.058	-.016	.000	-.928	-.796	-.176	.076	13.127
TDYrate	-.904	.589	-.446	-1.537	.199	-2.539	.730	.798	-.609	-.103	.053	18.743
ForceShape	-15.676	.650	-.216	-2.049	.110	-36.917	5.564	-.258	-.716	-.137	.405	2.471
ACPrate	.850	.299	.742	2.840	.047	.019	1.681	.823	.818	.190	.066	15.203
Married	1.009	1.151	.117	.876	.430	-2.188	4.206	-.330	.401	.059	.253	.946
nonSOSres	-.324	.261	-.097	-1.242	.282	-1.049	.401	-.218	-.527	-.083	.732	1.367
Unemployed	-.128	.196	-.013	-.058	.956	-6.226	5.970	.767	-.029	-.004	.094	10.606
O5Promotion	-.239	.575	-.047	-.415	.699	-1.834	1.357	.233	-.203	-.028	.350	2.854
Mean_Salary	.000	.000	.173	.826	.455	-.001	.001	.677	.382	.055	.103	9.725
(Constant)	29.257	9.441		.492	.643	-123.541	182.054					
PilotHires	-.008	.002	-.628	-4.708	.005	-.012	-.003	-.928	-.903	-.282	.202	4.945
TDYrate	-.896	.510	-.441	-1.757	.139	-2.206	.414	.798	-.618	-.105	.057	17.555
ForceShape	-15.443	5.830	-.213	-2.649	.045	-30.430	-.456	-.258	-.764	-.159	.558	1.792
ACPrate	.840	.224	.733	3.748	.013	.264	1.417	.823	.859	.225	.094	10.659
Married	.998	1.016	.115	.982	.371	-1.613	3.609	-.330	.402	.059	.261	3.837
nonSOSres	-.327	.230	-.098	-1.418	.215	-.919	.266	-.218	-.535	-.085	.752	1.329
O5Promotion	-.244	.508	-.048	-.480	.651	-1.549	1.061	.233	-.210	-.029	.359	2.782
Mean_Salary	.000	.000	.179	1.147	.303	.000	.001	.677	.457	.069	.147	6.790
(Constant)	28.753	55.490		.518	.623	-107.027	164.533					
PilotHires	-.007	.001	-.609	-5.111	.002	-.011	-.004	-.928	-.902	-.286	.221	4.532
TDYrate	-.786	.425	-.387	-1.848	.114	-1.826	.255	.798	-.602	-.103	.071	14.012

ForceShape	-16.693	4.871	-.230	-3.427	.014	-28.611	-4.774	-.258	-.814	-.192	.697	1.435
ACPrate	.780	.174	.681	4.495	.004	.355	1.205	.823	.878	.252	.137	7.325
Married	.707	.761	.082	.929	.389	-1.156	2.569	-.330	.354	.052	.405	2.472
nonSOSres	-.326	.215	-.098	-1.513	.181	-.852	.201	-.218	-.526	-.085	.752	1.329
Mean_Salary	.000	.000	.164	1.149	.294	.000	.001	.677	.425	.064	.154	6.511
(Constant)	76.498	20.659		3.703	.008	27.647	125.349					
PilotHires	-.007	.001	-.566	-5.209	.001	-.010	-.004	-.928	-.892	-.289	.260	3.843
TDYrate	-.570	.352	-.281	-1.617	.150	-1.403	.263	.798	-.522	-.090	.102	9.816
ForceShape	-17.825	4.669	-.245	-3.817	.007	-28.866	-6.784	-.258	-.822	-.212	.744	1.345
ACPrate	.763	.171	.666	4.464	.003	.359	1.167	.823	.860	.247	.138	7.238
nonSOSres	-.324	.213	-.097	-1.523	.172	-.828	.179	-.218	-.499	-.084	.752	1.329
Mean_Salary	9.24E-5	.000	.067	.695	.510	.000	.000	.677	.254	.038	.333	3.004
(Constant)	78.288	19.824		3.949	.004	32.575	124.001					
PilotHires	-.007	.001	-.549	-5.361	.001	-.009	-.004	-.928	-.884	-.287	.274	3.654
TDYrate	-.454	.300	-.224	-1.512	.169	-1.147	.239	.798	-.471	-.081	.131	7.630
ForceShape	-18.822	4.297	-.259	-4.380	.002	-28.731	-8.913	-.258	-.840	-.235	.821	1.218
ACPrate	.776	.164	.677	4.728	.001	.398	1.155	.823	.858	.253	.140	7.145
nonSOSres	-.333	.206	-.100	-1.621	.144	-.808	.141	-.218	-.497	-.087	.755	1.324
(Constant)	54.265	12.677		4.281	.002	25.589	82.942					
PilotHires	-.006	.001	-.493	-4.831	.001	-.009	-.003	-.928	-.850	-.277	.316	3.167
ForceShape	-19.133	4.589	-.263	-4.170	.002	-29.513	-8.753	-.258	-.812	-.239	.823	1.215
ACPrate	.590	.116	.515	5.087	.001	.328	.852	.823	.861	.291	.321	3.119
nonSOSres	-.334	.220	-.100	-1.518	.163	-.831	.164	-.218	-.451	-.087	.755	1.324
(Constant)	39.317	8.488		4.632	.001	20.405	58.228					
PilotHires	-.007	.001	-.557	-5.661	.000	-.009	-.004	-.928	-.873	-.345	.383	2.612
ForceShape	-19.871	4.851	-.273	-4.096	.002	-30.680	-9.062	-.258	-.792	-.250	.832	1.201
ACPrate	.522	.114	.456	4.588	.001	.269	.776	.823	.823	.279	.376	2.659

a. Dependent Variable: CCR

Backward Stepwise Regression Charts

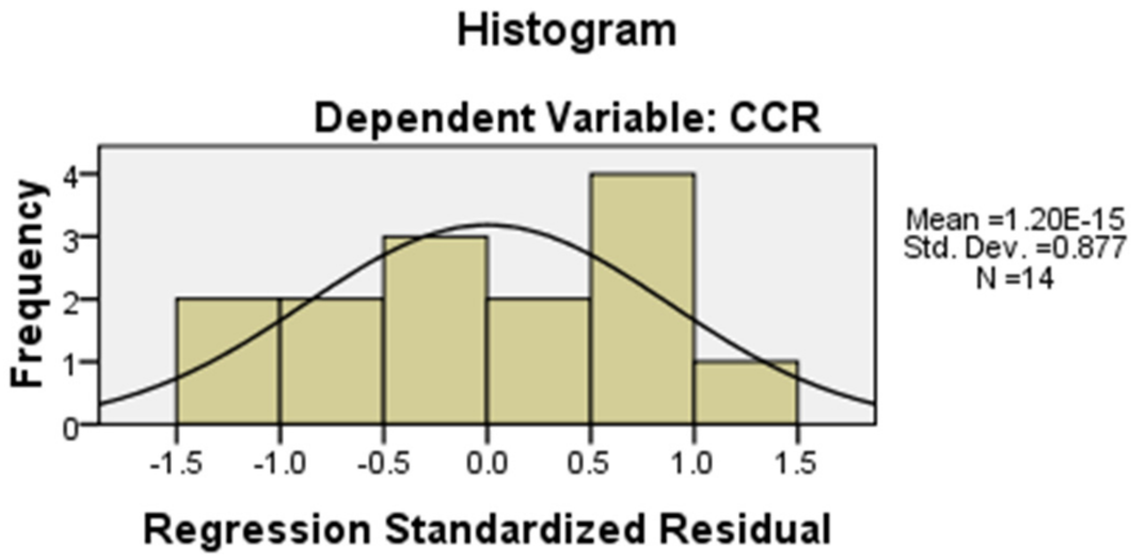


Figure 9: Backward Stepwise Regression Histogram

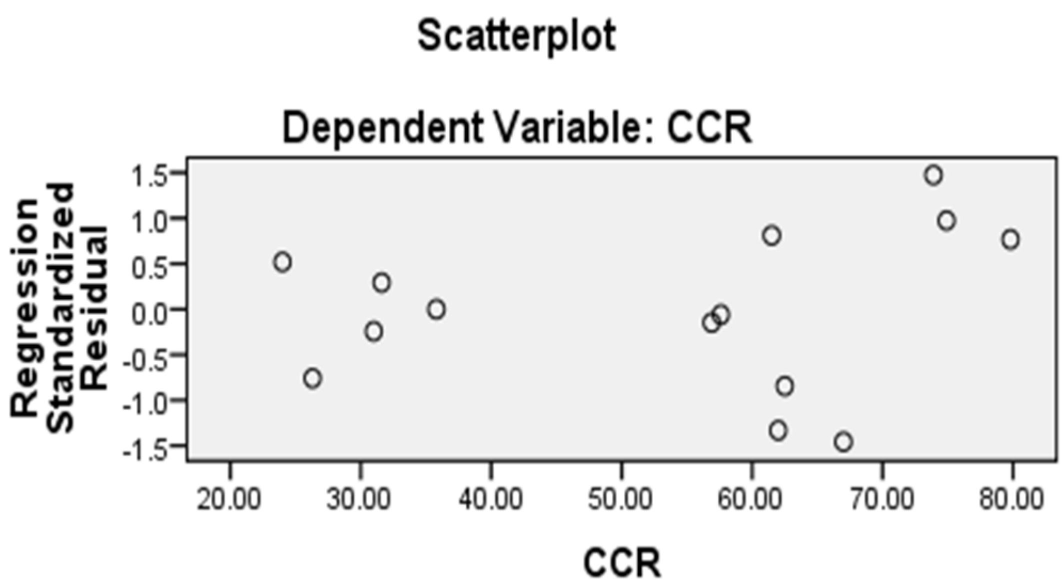
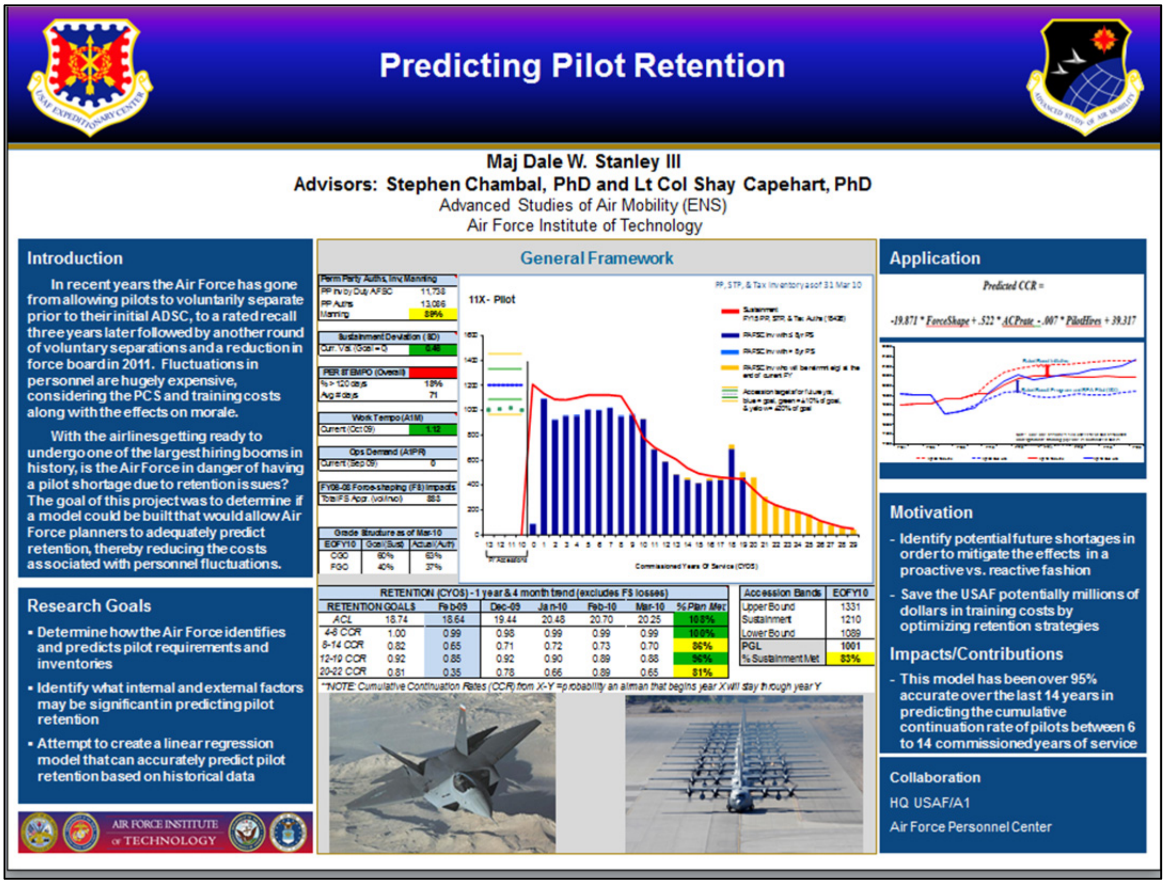


Figure 10: Backward Stepwise Regression Scatterplot

Appendix E: AFIT Quad Chart



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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 074-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From – To)
15 June 2012	Master's Graduate Research Project	May 2011 – 15 June 2012

4. TITLE AND SUBTITLE	
Predicting Pilot Retention	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER N/A
Stanley III, Dale W., Maj, USAF	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)	8. PERFORMING ORGANIZATION REPORT NUMBER
Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/ENV) 2950 Hobson Way, Building 640 WPAFB OH 45433-8865	AFIT-IMO-ENS-12-13
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)** HAF/A1PP
Headquarters Air Force, Military Force Policy Division Colonel Kenneth Sersun, Chief, Military Force Policy Division, HQ USAF/A1PP 1040 Air Force Pentagon, Room 4D950A, Washington, DC 20330 (703) 695-4225 DSN 225-; kenneth.sersun@pentagon.af.mil	**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The research problem is to determine if it is possible to predict future pilot retention based on factors internal and external to the Air Force to determine if there is a potential future shortage. Specifically, this research sought to answer three research questions about how future pilot inventories are forecast, determining if there are factors that may predict retention habits, and finally if a model can be formulated using those factors that would help predict pilot retention. This study will be focused towards the Air Staff and OSD to illustrate potential manning shortfalls as well as hopefully identifying factors that may alleviate those risks. This study focused solely on pilots and only look ten years out for requirements since the current ADSC for initial pilot training is ten years. Research indicated that the USAF does not use external factors that have proven to be significant in predicting pilot retention. This research created a formula for predicting pilot retention that can be used by senior policy members to better forecast retention behavior in order to shape force management more effectively.

15. SUBJECT TERMS
Pilot Retention, Linear Regression, Cumulative Continuation Rates

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Capehart, Shay R, Lt Col, Ph.D, AFIT
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (Include area code)
U	U	U	UU	66	(937) 255-6565, x 4516 (Shay.Capehart@afit.edu)

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Prescribed by ANSI Std. Z39-18